Emotional Processing in PTSD

Heightened Negative Emotionality to Unpleasant Photographic Stimuli

Erika J. Wolf, MA,† Mark W. Miller, PhD,*†‡ and Ann E. McKinney, MA**

Abstract: This study evaluated evidence for 2 forms of emotional abnormality in posttraumatic stress disorder (PTSD): numbing and heightened negative emotionality. Forty-nine male veterans with PTSD and 75 without the disorder rated their emotional responses to photographs that depicted scenes of Vietnam combat or were drawn from the International Affective Picture System (Lang et al., 2005). Images varied in their trauma-relatedness and affective qualities. A series of repeated measures ANOVAs revealed that Vietnam combat veterans with PTSD responded to unpleasant images with greater negative emotionality (i.e., enhanced arousal and lower valence ratings) than those without the disorder and this effect was modified by the trauma-relatedness of the image with stronger effects for trauma-related images. In contrast, the 2 groups showed equivalent patterns of responses to pleasant images. Findings raise questions about the sensitivity of the International Affective Picture System rating protocol for the assessment of PTSD-related emotional numbing.

Key Words: PTSD, emotional processing, IAPS, assessment.

(*J Nerv Ment Dis* 2009;197: 419–426)

The nature of the emotional processing abnormalities in posttraumatic stress disorder (PTSD) has been the source of theoretical disagreement and conflicting findings. The DSM-IV (American Psychiatric Association [APA]; 1994) diagnosis includes examples of both attenuated and exaggerated emotional responsivity. The former is reflected in the emotional numbing symptom (Criterion C-6) and is thought to involve a "restricted range of affect" (APA, 1994, p. 428). Researchers have conceptualized this as either (*a*) a generalized dampening of the capacity to experience both positive and negative emotions (Herman, 1997; Glover, 1992) or (*b*) a specific phasic deficit in the ability to experience positive emotions (Litz, 1992). Exaggerated emotional responses are denoted in Criterion B-4: "intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event," and in Criterion D-2: "irritability or outbursts of anger" (APA, 1994, p. 428).

Prior efforts to clarify the nature of these emotional processing abnormalities have employed a range of methodologies including self-report emotion ratings, psychophysiology, and indices of fear-related brain activation, but have yielded conflicting findings. Self-report studies have shown various patterns of results ranging from: (*a*) no differences in ratings under neutral conditions between individuals with versus without PTSD (Litz et al., 2000; Miller and Litz, 2004; Wessa et al., 2005), (*b*) enhanced ratings of discrete negative emotions in response to nontrauma-related photographs and films (Amdur et al., 2000; Orsillo et al., 2004), (*c*) diminished ratings of specific positive emotions during image processing (Amdur et al., 2000), (*d*) diminished ratings of arousal in response to pleasant photographs (Spahic-Mihajlovic et al., 2005), to (*e*) increased ratings of arousal and unpleasant affect in response to trauma-related photographs in both recently traumatized individuals and those with PTSD (Elsesser et al., 2004). Psychophysiological studies, in comparison, have produced fairly consistent evidence of heightened physiological reactivity to trauma cues in individuals with PTSD relative to controls (for a review, see Orr et al., 2004). However, neuroimaging studies examining amygdala activity have found evidence of enhanced fear reactivity to both trauma-related (Liberzon et al., 1999; Rauch et al., 1996; Shin et al., 2004) and nontrauma-related unpleasant stimuli in individuals with PTSD (Rauch et al., 2000; Shin et al., 2005). Other studies that have included direct comparisons of physiological responses to trauma- and nontrauma-related unpleasant stimuli have shown support for the trauma-specificity of emotional hyper-responsiveness in PTSD (Casada et al., 1998; Miller and Litz, 2004; Protopopescu et al., 2005), but this issue has not been comprehensively examined using self-report measures. Research on the subjective experience of emotion in individuals with PTSD is important for understanding the nature of the affective abnormalities in the disorder and for the development and refinement of treatments that target these problems. The present study was designed to address this by assessing self-reported emotional responses to stimuli that varied in their affective properties and trauma-relatedness using photographs drawn largely from the International Affective Picture System (IAPS)(Lang et al., 2005).

The IAPS and the Study of Emotional Processing

The IAPS is the most widely used standardized stimulus set for the study of emotion in the laboratory. It is comprised of an array of emotionally evocative photographic images depicting a wide range of human experiences. The images were normed on college students and have been used in hundreds of basic and clinical research studies internationally. The assessment of self-reported responses to these images has emphasized 2 dimensions of emotion—valence (i.e., pleasantness) and arousal (i.e., activation)—on the basis of a 2-factor model developed originally by Russell and Mehrabian, (1977) and advanced by Peter Lang et al., (Lang et al., 1998; Lang et al., 1993). From this standpoint, valence corresponds to the direction of the response tendency evoked by an affective stimulus (i.e., pleasant/approach vs. unpleasant/withdrawal) whereas arousal corresponds to the strength of activation of that behavioral disposition. IAPS-based ratings of valence and arousal exhibit a quadratic relationship: as valence becomes increasingly pleasant or unpleasant relative to neutral, ratings of arousal increase (IAPS; Lang et al., 2005).

The Present Study

The primary aim of this study was to evaluate alternative hypotheses regarding the nature of the emotional processing abnor-

*National Center for PTSD, Veterans Affairs Boston Healthcare System, Boston, Massachusetts; †Department of Psychology, Boston University, Boston, Massachusetts; and ‡Department of Psychiatry, Boston University School of Medicine, Boston, Massachusetts.

Supported by National Institute of Mental Health grant (5F31MH074267) awarded (to E.J.W.).

Send reprint requests to Mark W. Miller, PhD, National Center for PTSD, VA Boston Healthcare System, 150 S. Huntington Ave. (116B-2), Boston, Massachusetts, 02130. E-mail: mark.miller5@va.gov.

ISSN: 0022-3018/09/19706-0419
DOI: 10.1097/NMD.0b013e3181a61c68

malities in PTSD. We tested 2 competing hypotheses for the attenuation of emotions in PTSD: First, we hypothesized that if the disorder involves a generalized numbing of emotions (Hypothesis 1a), then individuals with PTSD would show lower mean arousal (i.e., reduced emotional activation) and/or valence ratings (i.e., less pleasant/greater unpleasant affect) for both pleasant and unpleasant photographs relative to controls. Second, if the disorder involves the hypoactivation of positive emotions only (Hypothesis 1b), then we should see evidence of lower mean arousal and/or valence ratings for pleasant images only in the PTSD group. We also examined 2 alternative hypotheses concerning the exaggerated experience of negative emotion in PTSD. The first was that if PTSD involves a generalized enhancement of negative responses to unpleasant emotional stimuli (Hypothesis 2a), then this should be evident in (*a*) greater ratings of arousal/activation, and (*b*) lower valence ratings in response to unpleasant images in the PTSD group compared with controls, irrespective of the trauma-relatedness of the stimulus. Alternatively, if heightened negative emotionality in PTSD is specific to trauma-related stimuli (Hypothesis 2b), then these effects should be evident in exaggerated responses in Vietnam-combat veterans with PTSD only when viewing Vietnam combat related images.

The second aim was to generate norms for male Vietnam veterans using 150 IAPS images plus a new collection of 30 Vietnam War-related photographs. Combat-related stimuli are frequently used in studies of Vietnam veterans with PTSD, but no standardized stimulus set with established norms has been available to investigators working with this population. We decided to use a large stimulus set of 180 images because prior studies reporting no PTSD group differences in self-report ratings of emotion had employed far fewer images, raising the possibility that PTSD-related differences might be observable with a wider array of stimuli. A larger and more varied stimulus set would be expected to increase the reliability and sensitivity of the measurement of emotion and provide greater coverage of the stimulus properties necessary to activate the affective networks underlying emotional experience (Lang, 1979).

METHOD

Participants

Participants were 124 male veterans recruited at a Department of Veterans Affairs Medical Center. The sample included 36 individuals (29%) who identified themselves as combat veterans of the Vietnam War, 40 Vietnam-era veterans (32%) who did not serve in the Vietnam War (i.e., they were stationed elsewhere at the time of the war), 12 veterans (10%) from the Desert Storm conflict, and 35 veterans (28%) who did not serve during war-time. The mean age of the sample was 48 (*SD* = 7.26). Participants reported their ethnicity as follows: 69% (*n* = 86) White, 22% (*n* = 27) Black or African American, 3% (*n* = 4) Hispanic, and 5% (*n* = 6) other ethnicity. Forty-nine veterans met criteria for probable PTSD, as defined below. Demographic characteristics of the PTSD and no-PTSD groups are provided in Table 1. As shown in Table 1, veterans with PTSD scored higher on all indicators of psychopathology (i.e., PTSD and depression) as compared with those without the disorder,

TABLE 1. Descriptive Characteristics of the Study Groups

	All Veterans (*N* = 124)				Vietnam Combat Veterans (*n* = 36)			
	PTSD (*n* = 49)	No PTSD (*n* = 75)	*t* (*df* = 121)	χ^2 (*df*)	PTSD (*n* = 18)	No PTSD (*n* = 18)	*t* (*df* = 34)	χ^2 (*df*)
Demographic measures								
Mean age (*SD*)	47 (7.41)	49 (7.08)	1.21		53 (2.63)	54 (3.90)	1.10	
Ethnicity (%)				10.59 (5, *N* = 123)				3.44 (3, N = 36)
White	71 (*n* = 35)	68 (*n* = 51)			61 (*n* = 11)	67 (*n* = 12)		
African American	14 (*n* = 7)	27 (*n* = 20)			22 (*n* = 4)	33 (*n* = 6)		
Hispanic	4 (*n* = 2)	3 (*n* = 2)			5 (*n* = 1)	0		
Other	10 (*n* = 5)	2 (*n* = 1)			0	0		
War Era (%)				.63 (2, *N* = 123)				N/A
Vietnam	65 (*n* = 32)	59 (*n* = 44)			100 (*n* = 18)	100 (*n* = 18)		
Desert Storm	10 (*n* = 5)	9 (*n* = 7)			0	0		
Other[a]	25 (*n* = 12)	32 (*n* = 23)			0	0		
Mean combat exp. (*SD*)	N/A	N/A			25.06 (7.84)	17.19 (10.11)	2.46*	
Psychopathology Measures: Mean (*SD*)								
PTSD Checklist								
Total Score	63.00 (9.27)	32.09 (10.20)	17.05**		61.83 (9.83)	31.22 (10.16)	9.19**	
Reexp. Sx.	18.25 (3.59)	8.84 (4.06)	12.79**		17.72 (3.66)	8.22 (3.80)	7.64**	
Avoidance Sx.	7.45 (1.87)	3.78 (1.90)	10.52**		7.39 (1.97)	3.39 (1.58)	6.72**	
Em. Numbing Sx.	18.35 (3.59)	10.04 (4.15)	11.45**		18.28 (4.09)	9.67 (3.88)	6.49**	
Hyperarousal Sx.	18.96 (3.20)	9.43 (3.18)	16.22**		18.44 (3.50)	9.94 (3.35)	7.64**	
BSI: GSI (raw score)	1.67 (0.56)	0.46 (0.32)	15.13**		1.60 (0.64)	0.45 (0.30)	6.89**	
BSI: Depression (raw score)	2.20 (0.97)	0.67 (0.64)	10.58**		2.04 (1.04)	0.60 (0.57)	5.12**	

The Combat Exposure Scale was administered only to the Vietnam combat veterans. PTSD indicates posttraumatic stress disorder; *SD,* standard deviation; DF, degrees of freedom; Exp, exposure; Reexp, reexperiencing; Sx, symptoms; Em, emotional; BSI, Brief Symptom Inventory; GSI, Global Severity Index. Avoidance scores are the sum of items 6–7 on the PTSD Checklist (PCL) and emotional numbing scores are the sum of items 8–12 on the PCL.

[a]Other refers to veterans who did not serve during war time.

*$p < 0.05$. **$p < 0.001$.

but the 2 groups did not differ in terms of age or ethnicity. The inclusion of the Vietnam combat veteran subsample allowed us to examine emotional responding to trauma-related Vietnam War images in Vietnam combat veterans with and without PTSD. Among this subsample, 50% ($n = 18$) met criteria for probable PTSD. Demographic characteristics of the PTSD and no-PTSD groups within the Vietnam combat veteran subsample are shown on the right side of Table 1. Vietnam combat veterans with PTSD scored higher on combat exposure and on all measures of psychopathology, but did not differ in age or ethnicity relative to Vietnam combat veterans without PTSD (see Table 1). Vietnam combat veterans with PTSD and other veterans with PTSD did not differ in the severity of their PTSD or depression symptoms (t [47] = 0.68, $p = 0.51$ and t [47] = 0.92, $p = 0.36$, respectively). Four additional participants were omitted from analyses due to equipment failure and 5 due to a disproportionate amount (>20%) of missing ratings data. Data from 3 additional individuals were omitted because of the presence of extreme outliers (valence and/or arousal ratings exceeded 3 standard deviations from the sample mean) on a minimum of 20% of the images.

Procedure

Data were collected in a quiet, private laboratory suite under normal room lighting. After providing written informed consent, participants were seated in a comfortable chair with a computer mouse and pad attached to the arm of the chair located approximately 3 ft. (0.9 m) in front of a 20-inch (50.8 cm) computer monitor. Participants completed a series of self-report questionnaires administered via computer using the MediaLab software (Empirisoft Corporation, 1995–2002); they then viewed and rated their emotional responses to the 180 photographs. Each image was presented for 6 seconds using the SuperLab Pro software (Cedrus Corporation, 1999). Following each presentation, participants recorded their emotional response to it on the dimensions of valence and arousal using a 9-point Self-Assessment Manikin (SAM; Bradley and Lang, 1994) then the next slide was presented immediately. Valence ratings are bi-polar in nature; the SAM figure depicts emotions which range from "very unpleasant" to "very pleasant" with the midpoint of the scale reflecting neutral valence. Arousal ratings are uni-polar in nature—the SAM figure depicts emotional intensity ranging from "very calm" to "very activated" with the midpoint of the scale reflecting a moderate level of activation. This scale distinction was explained to participants at the beginning of the image ratings procedure using instructions developed by Lang et al., (2005). In addition, participants were instructed to make their ratings based on how they felt in response to each image and not to rate the qualities of the image itself. After presentation of each Vietnam War-related image, Vietnam combat veterans also rated the similarity of the photograph to their own experiences in the War on a 9-point scale. The image viewing and emotion ratings procedure was approximately 1 hour in duration.

Images

Stimuli were 150 photographs from the IAPS and 30 Vietnam War-related photographs duplicated from prints at the National Archives and digitized for computer display. IAPS images were chosen to vary in content, affective properties, and intensity. In total, 90 pleasant and 60 unpleasant IAPS images were selected. (A list of the specific IAPS images and mean ratings for each image by group is available from the corresponding author). Pleasant images included scenes of affectionate or erotic couples, nude pictures of the opposite-sex, exciting activities, and cute babies and pets. Unpleasant pictures included depictions of horrific life events, body mutilations, violent assaults, and transportation accidents. Vietnam War photographs portrayed soldiers engaged in combat, dead or wounded soldiers and civilians, and other horrific scenes associated with the War. These images included details (e.g, the uniforms worn by soldiers, their weaponry and equipment, the landscape, and the ethnicity of the civilians) that made them readily identifiable to this sample as being from the Vietnam War.

IAPS images were categorized a priori according to their pleasantness (i.e., unpleasant versus pleasant) and intensity (i.e., low, medium, or high) based on published norms (Lang et al., 2005). In addition, the Vietnam War images were assigned an image intensity level on the basis of mean ratings that were generated during a pilot study conducted with healthy males (the Vietnam War images were all in the unpleasant valence category). Mean arousal ratings (from the norms) for pleasant and unpleasant images were matched at each level of image intensity and paired-sample t-tests showed no differences in the normative ratings of arousal as a function of image pleasantness at any of the intensity levels.

Study Design

To minimize serial position effects, 4 counterbalanced image sequences were generated by creating 4 sets of 45 images with equal numbers of pleasant and unpleasant images in each. These 4 sets were then arranged in a balanced Latin square design to create the 4 counterbalancing orders. Participants were randomly assigned to 1 of these 4 orders.

Measures

PTSD Checklist

The PCL, a 17-item self-report inventory of the PTSD Checklist (PCL; Weathers et al., 1993) symptomatology, was used to determine probable PTSD diagnosis. A cut-off score of 50 was recommended by Weathers et al. (1993) and has been shown to yield good diagnostic sensitivity and specificity (0.78 and 0.86, respectively), when compared with diagnoses made with the Clinician Administered PTSD Scale (Blanchard et al., 1996). Probable PTSD in the current study was indicated by a total score of 50 or greater on the PCL plus endorsement of at least 1 reexperiencing, 3 avoidance, and 2 hyperarousal symptoms, with each symptom endorsed at least at a moderate level of severity (i.e., a score of 3 or greater on a 5-point scale), consistent with DSM-IV diagnostic criteria. The PCL has been shown to have excellent test-retest reliability ($r = 0.96$; Weathers et al., 1993) and concurrent validity compared with structured clinical interviews of PTSD ($r = 0.93$; Blanchard et al., 1996). Internal consistency of the measure in the present sample was excellent (Cronbach alpha = 0.96). Combat veterans completed the Military version of the PCL, in which participants reported on symptoms in reference to stressful military experiences, while noncombat veterans completed the Civilian version of the PCL.

Combat Exposure Scale

The Combat Exposure Scale (CES; Keane et al., 1989) was used to quantify military combat exposure. This measure assesses the number of times individuals were exposed to each of 7 combat experiences on a 1 to 5 scale. A prior investigation of the psychometric properties of the CES in Vietnam-era veterans demonstrated that the measure is highly reliable (Cronbach alpha = 0.85, test-retest reliability = 0.97) and that higher scores on the CES are associated with positive PTSD status in veterans (Keane et al., 1989). This measure was administered to the Vietnam combat veterans only.

Brief Symptom Inventory

The Brief Symptom Inventory (BSI; Derogatis, 1992) was used as an indicator of general psychiatric symptomatology and depression. This 53-item measure asks respondents to rate how

bothered they have been by psychological symptoms in the past month on a 0 to 4 scale. Analyses focused on 2 indices from this measure: (*a*) the Depression dimension, which is comprised of 6 items, and (*b*) the Global Severity Index (GSI), which reflects the mean score for all items (e.g, a general indicator of psychopathology). Test-retest reliability of these scales is excellent (rs = 0.90 and 0.84, respectively; Derogatis, 1992).

Data Analysis

Data analyses were performed in a 2-part sequence. First, we evaluated the internal validity of the study by (*a*) verifying that assignment to the different counterbalancing orders was not systematically related to ratings of emotion or diagnostic group, (*b*) examining whether participants rated images differently as a function of the serial position of the image (e.g, if they habituated to the ratings task over time), and (*c*) evaluating the reliability of valence and arousal ratings by comparing the veteran ratings to the IAPS norms.

Second, we employed a series of repeated measures ANOVAs to examine evidence for PTSD-related hyper- and hypo-emotional activation. First, we examined differences in ratings of arousal as a function of image pleasantness (2 level), intensity (3 level) and PTSD group status (2 level) in a 2 × 3 × 2 repeated measures ANOVA using the whole sample. Next, we examined differences in ratings of arousal as a function of the trauma-relatedness of the stimuli (Vietnam War-related vs. nontrauma-related unpleasant image) and PTSD group in a 2 × 2 repeated measures ANOVA. This analysis was conducted in the Vietnam combat veteran subsample. We then performed the same analyses using ratings of valence as the dependent variable.

RESULTS

Internal Validity

A chi square analysis revealed no differences in the frequency with which subjects with versus without PTSD were randomized to the 4 counterbalancing orders, chi square (3, $N = 124$) = 1.45, $p = 0.69$. There was no association between counterbalancing order and mean ratings of arousal ($r = -0.01$, $p = 0.87$) or valence ($r = 0.13$, $p = 0.14$), nor was there an association between the serial position of an image and ratings of valence or arousal for pleasant or unpleasant images (rs ranged from −0.06 to 0.03, mean $r = -0.04$). Correlations between the IAPS male norms and veterans' ratings (both with and without PTSD) showed a high degree of consistency (Valence $r = 0.97$, $p < 0.001$; Arousal $r = 0.86$, $p < 0.001$). We next generated normative ratings for each image for all veterans, and for each veteran subgroup (e.g, Vietnam veterans, those with and without PTSD). These norms are available from the corresponding author.

Evaluating Alternative Hypotheses: Group Differences in Ratings of Arousal

PTSD group differences in ratings of arousal were examined by conducting a 2 × 3 × 2 repeated measures ANOVA, using our IAPS-based a priori categorizations of image pleasantness (i.e., pleasant vs. unpleasant) and intensity (i.e., low, medium, and high) as within-subject factors and PTSD as between-subject factor. This analysis revealed significant main effects for Pleasantness (F [1, 122] = 5.30, $p < 0.05$), Intensity (F [2, 121] = 85.29, $p < 0.001$), as well as significant Pleasantness X Intensity (F [2, 121] = 4.18, $p < 0.05$) and Pleasantness X Intensity X PTSD interactions (F [2, 121] = 3.62, $p < 0.05$). We decomposed the latter interaction term by analyzing data for pleasant and unpleasant images separately.

For unpleasant images, there was a main effect of Intensity (F [2, 121] = 35.07, $p < 0.001$) on Arousal and a significant Intensity X PTSD interaction (F [2, 121] = 3.03, $p = 0.05$). Results further revealed that the Intensity X PTSD interaction was linear in nature (F [1, 122] = 6.02, $p < 0.05$), indicating that differences in arousal ratings between the low and high levels of image intensity were moderated by PTSD status. Examination of group means suggested that individuals with PTSD showed a flatter rise in arousal ratings from the low to high levels of image intensity, relative to the non-PTSD veterans (low arousal no-PTSD mean = 4.69; high arousal no-PTSD mean = 5.49; low arousal PTSD mean = 5.17; high arousal PTSD mean = 5.62). There was no main effect of PTSD on arousal ratings in response to unpleasant images (F [1, 122] = 0.89, $p = 0.35$). For pleasant images, there was a significant main effect of Intensity only (F [2, 121] = 68.90, $p < 0.001$)—there was no effect of PTSD on ratings of arousal during viewing of pleasant images.

Group Differences in Arousal Ratings in Response to Trauma-Related Versus Nontrauma-Related Images

We next examined if arousal ratings in response to the unpleasant images might differ as a function of the trauma-relatedness of the image and PTSD group status. To do so, we limited the analysis to data from the Vietnam combat veterans, since this was the only group for whom the Vietnam War images would be directly trauma-relevant. We then conducted a 2-way repeated measures ANOVA in which image type (nontrauma-related unpleasant vs. trauma-related Vietnam War image) was the within-subject factor and PTSD status was the between subject factor. This analysis revealed main effects of Image Type (F [1, 34] = 15.32, $p < 0.001$ and PTSD (F [1, 34] = 9.59, $p < 0.01$), and a significant Image Type X PTSD interaction (F [1, 34] = 4.69, $p < 0.05$). Examination of the group means suggested that veterans with PTSD responded to all of the unpleasant images with greater arousal relative to the controls (mean for PTSD group = 5.34; mean for no PTSD group = 3.98). The significant interaction indicated that the effect of PTSD was greater for the Vietnam War images relative to the nontrauma-related unpleasant images (see top panel of Fig. 1).

We next examined if the finding of heightened self-rated arousal during viewing of Vietnam War-related images in the PTSD group was due to individual differences in combat exposure or due to the similarity between the images and veterans' actual war experiences. To do so, we simultaneously regressed mean ratings of arousal in response to the Vietnam images on dimensional indicators of PTSD severity (PCL scores), combat exposure (CES scores), and veterans' self-report ratings of the similarity of each Vietnam image to their own war experience. Results indicated that neither Combat Exposure nor Image Similarity was a significant predictor of ratings of arousal in response to the trauma-related Vietnam War images ($\beta = 0.19$, $p = 0.33$; $\beta = 0.19$, $p = 0.34$, respectively), while PTSD Severity was significantly related to ratings of arousal ($\beta = 0.46$, $p < 0.01$; Multiple $R = 0.69$).

We also conducted secondary analyses to examine the influence of depression on these ratings. To do so, we first examined the correlations between dimensional ratings of depression (as measured by the 6-item Depression subscale on the BSI), PCL scores, and ratings of arousal in response to the Vietnam War images (in the Vietnam combat subsample). Depression and PTSD were strongly related to one another ($r = 0.80$, $p < 0.001$) and to ratings of arousal in response to the Vietnam images ($r = 0.31$, $p = 0.07$ and $r = 0.45$, $p < 0.01$, respectively) at the zero-order level. However, when both depression and PTSD were entered simultaneously into a regression predicting mean arousal ratings in response to the Vietnam images, only PTSD emerged as a significant predictor (β for PTSD = 0.57, $p < 0.05$; β for Depression = −0.15, $p = 0.57$). Additionally,

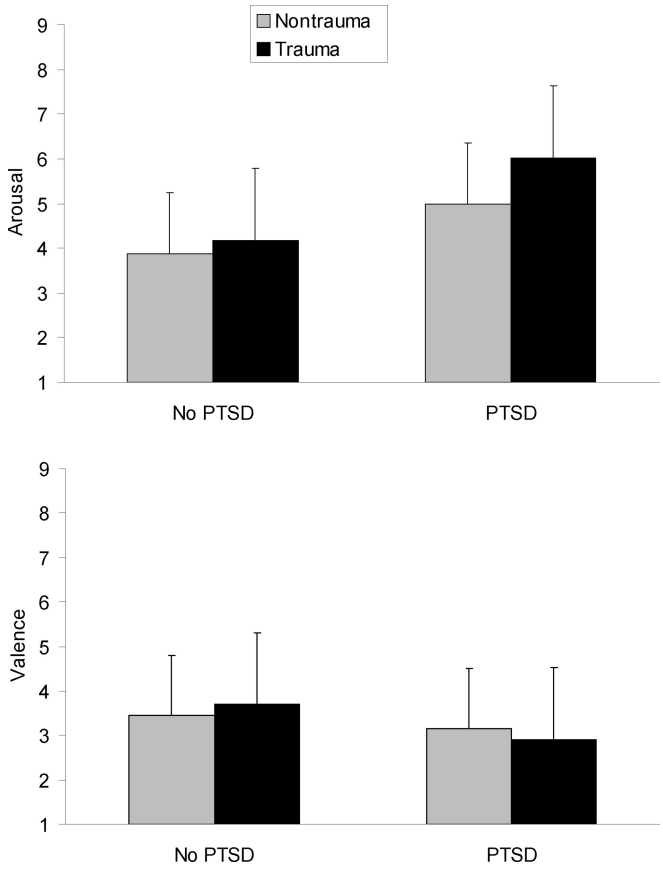

FIGURE 1. Mean arousal (top panel) and valence (bottom panel) ratings of unpleasant images as a function of PTSD and the trauma-relatedness of the image in the Vietnam-combat veterans ($n = 36$). Ratings of arousal range from "very calm" (1) to "very activated" (9). Ratings of valence range from "very unpleasant" (1) to "very pleasant" (9) with neutral valence reflected at the midpoint of the scale. Error bars reflect standard error.

depression was not associated with ratings of arousal in response to the nontrauma-related unpleasant photographs ($r = 0.06$). We also examined the extent to which depression was associated with ratings of arousal in response to pleasant images and found no evidence that depression was associated with arousal ratings in response to pleasant photographs ($r = 0.08$).

Evaluating Alternative Hypotheses: Group Differences in Ratings of Valence

We next conducted an analogous series of repeated measures ANOVAs with self-report ratings of valence as the dependent variable. The 2 × 3 × 2 ANOVA examining the effects of image Pleasantness, Intensity, and PTSD revealed main effects of Pleasantness ($F\,[1, 122] = 1054.22$, $p < 0.001$), Intensity ($F\,[2, 121] = 8.80$, $p < 0.001$), as well as significant Pleasantness X Intensity ($F\,[2, 121] = 106.21$, $p < 0.001$) and Intensity X PTSD ($F\,[2, 121] = 3.07$, $p = 0.05$) interactions. The latter interaction was linear in nature ($F\,[1, 122] = 5.83$, $p < 0.05$). Examination of the group means for valence ratings in the lowest and highest image intensity levels (collapsed across image pleasantness) suggested that the effect of PTSD was specific to the low intensity images in that veterans with PTSD tended to rate low intensity images (e.g, fairly neutral images) as somewhat more unpleasant relative to the veterans without PTSD (mean valence ratings for the low intensity images = 4.79 and 4.56 for the no-PTSD and PTSD groups, respectively; mean valence rating for the high intensity images = 4.58 and 4.53 for the no-PTSD and PTSD groups, respectively).

Group Differences in Valence Ratings in Response to Trauma-Related Versus Nontrauma-Related Images

We then conducted the Image Type X PTSD repeated measures ANOVA on ratings of valence in response to the unpleasant images (trauma-related and nontrauma-related) in the Vietnam War combat veteran subsample. This analysis yielded a main effect of PTSD status ($F\,[1, 34] = 5.43$, $p < 0.05$), indicating that veterans with PTSD tended to rate all the unpleasant images as more unpleasant than veterans without the disorder (mean for veterans with PTSD = 3.06, mean for veterans without = 3.53; lower values indicate more unpleasant affect). The ANOVA also revealed a significant Image Type X PTSD interaction ($F\,[1, 34] = 5.66$, $p < 0.05$) and examination of the group means suggested that the main effect of PTSD was greater for Vietnam War images (mean for no-PTSD group = 3.70 and for the PTSD group = 2.90) relative to the nontrauma-related unpleasant images (mean for no-PTSD group = 3.44 and for the PTSD group = 3.15; see bottom panel of Fig. 1). We next examined if depression might be contributing to valence ratings in response to the trauma-related Vietnam War images. Pearson correlations revealed that depression (as measured by the BSI) was not associated with ratings of valence in response to the Vietnam War images ($r = -0.10$, $p = 0.57$) while PTSD (as measured by the PCL) was correlated with these ratings such that greater PTSD severity was associated with more unpleasant valence ratings ($r = -0.36$, $p < 0.05$). Given the lack of an association between depression and ratings of valence at the zero-order level, we did not proceed with a multiple regression examining the relative contributions of depression and PTSD, as we did for ratings of arousal.

Finally, given the study's focus on emotional numbing and the lack of evidence for numbing in the preceding results, we verified that this symptom was well represented among veterans with PTSD by examining the percentage of veterans who endorsed PTSD Criterion C-6 on the PCL. Among those with PTSD, 88% endorsed this symptom at a level of 3 "moderately" or greater and 61% endorsed this symptom at a level of 4 "quite a bit" or greater. Comparatively, 30% and 14% of individuals without PTSD endorsed this item at these same levels.

DISCUSSION

The primary aim of this study was to evaluate competing hypotheses for 2 forms of affective abnormality described in the DSM-IV definition of PTSD: emotional numbing and heightened negative emotionality. Analyses provided support for exaggerated emotional responding only: Vietnam combat veterans with PTSD reported greater negative emotionality (i.e., greater arousal and more unpleasant affect) in response to unpleasant photographs compared with those without the disorder and this effect was greater for trauma-related than nontrauma-related images. The larger sample of all veterans with PTSD (including Vietnam combat veterans, other war veterans, and Vietnam-era veterans) provided only minimal evidence of self-reported emotional processing abnormalities: this group responded to relatively neutral, innocuous images with greater arousal and more unpleasantness (i.e., exaggerated responsivity), relative to those without the disorder.

To our knowledge, this is the first study to find heightened self-reported negative emotionality in response to both nontrauma-related and trauma-related negative photographic stimuli in individuals with PTSD. Elsesser et al. (2004) reported that both recently traumatized individuals and those with PTSD rated trauma-related photographs as more unpleasant and more arousing relative to a control group, but they did not find differences in ratings of affect in response to nontrauma-related unpleasant photographs. Similarly, Amdur et al. (2000) reported increases in specific negative emotions in response to a subset of highly evocative pictures, but did not find differences in ratings of valence or arousal in individuals with PTSD. One possible explanation for why we might have observed PTSD-group differences in self-reported arousal while the majority of prior investigations have not (Amdur et al., 2000; Litz et al., 2000; Miller and Litz, 2004) was that our stimulus set was comprised of 180 photographs and therefore depicted a wider range of emotion-evoking experiences. Although one might wonder if such a large number of images would increase participant fatigue, analyses showed no effect of task length (i.e., serial position) on patterns of response. Therefore, 1 methodological conclusion that can be drawn from this study is that it may be useful for investigators conducting future studies of this sort to increase the number of IAPS images employed and thereby increase the sensitivity of emotion measurement (but see discussion of emotional numbing, below).

Analyses also examined whether the finding of heightened negative activation in response to trauma-related photographs was specifically related to PTSD severity or other factors. We explored these possibilities by comparing the relative influence of (*a*) combat exposure, (*b*) veterans' ratings of the similarity of the Vietnam War photographs to their actual experiences, and (*c*) PTSD severity on responses to these images. Results showed that, of these variables, PTSD was the only significant predictor of arousal ratings. This suggests that heightened negative emotional activation in response to trauma-related images was not a function of the severity of combat exposure, or the self-rated similarity between trauma-related stimuli and actual experiences, but rather, reflected a process implicated in the psychopathology of PTSD.

We also examined 2 competing hypotheses regarding the attenuation of emotions in PTSD by evaluating evidence for (*a*) generalized dampening of both positive and negative emotion versus (*b*) numbing of positive emotion only. Results revealed no support for either hypothesis. Veterans with PTSD, who endorsed significant levels of emotional numbing on the PCL, were no less reactive to pleasant or unpleasant images than those without the disorder. The lack of evidence for emotional numbing in this study runs contrary to the common conception that individuals with PTSD suffer from a generalized restriction in the capacity to experience emotion (APA, 1994; Herman, 1997).

These findings raise questions about the sensitivity of the IAPS and SAM ratings protocol for the assessment of PTSD-related emotional abnormalities. In this study we did not observe substantive differences in IAPS ratings until we (1) limited the sample to the Vietnam combat veterans with- and without-PTSD and (2) limited the dependent variable to arousal and valence ratings in response to unpleasant images. Prior work by Amdur et al. (2000), Litz et al. (2000), Miller and Litz (2004), and Wessa et al. (2005) also found no differences between participants with and without PTSD in self-rated valence and arousal in response to photographic stimuli under baseline or neutral conditions. Similarly, some prior research with depressed samples has also failed to show group differences in ratings of valence and arousal in response to IAPS images (Allen et al., 1999) and those that have reported differences have yielded inconsistent results (see Dunn et al., 2004; Sloan et al., 1997; Sloan et al., 2001). To our knowledge, only 1 prior study (Spahic-Mihajlovic et al., 2005) has reported evidence of self-reported numbing in response to evocative images. In that study, Bosnian men and women with PTSD responded with lower arousal in response to pleasant photographs compared with controls. However, this finding was specific to just 4 of the most pleasant images in the stimulus set, and PTSD scores were nearly perfectly correlated with a measure of depression, raising questions about the generalizability and PTSD–specificity of those findings.

One possible explanation for the lack of evidence for emotional numbing across the majority of these self-report studies is that emotional numbing may be more likely to be observed reliably using measures of overt behavior, such as facial expressions of emotion in response to IAPS images (Litz et al., 2000), or when measuring self-reports of specific, discrete emotions (Amdur et al., 2000). It is also possible that emotional numbing may be phasic in nature, linked to the reexperiencing of the trauma, and reflective of a shift in mood or priming of a trauma-related conditioned emotional response (cf., Litz, 1992; Litz et al., 2000; Miller and Litz, 2004) and not evident under un-primed conditions as was the case in this study. Finally, it may also be the case that there is a disconnect between the experience of emotional numbing and the ability of individuals with PTSD to report on this experience; additional studies examining the synchrony of facial, physiological, and self-report measures of emotion relative to reports of mood are needed to more fully examine these possibilities.

Lastly, it is notable that the overall distribution of ratings in our veteran sample was highly correlated with the college student norms. This speaks to the generalizability of the IAPS stimulus set across these distinct populations and suggests that the basic structure of affective responses (e.g, the quadratic relationship between valence and arousal) is consistent across these groups, despite differences in age, life experiences, and psychopathology. However, the impressive stability of IAPS ratings across clinical and nonclinical groups also raises concern about whether objective properties of the images outweigh the subjective assessment of emotional responses that the protocol purports to reflect. Although participants in this study were specifically instructed to rate their subjective emotional experience in response to each image, rather than to rate the qualities of the image, it is still possible that ratings reflected the pleasantness and intensity of the images themselves. It might be helpful if future research using the SAM ratings included a protocol check—for example, the experimenter could talk with the participant about ratings made in response to a small number of training images to ensure that the protocol was well understood and being followed appropriately. On the other hand, evidence for the similarity of the pattern of affective ratings across our veteran sample and the normative sample may simply speak to the structural equivalence of the underlying organization of emotion.

Limitations and Conclusions

In addition to the study limitations noted above, the present study included only male, predominately Vietnam-era veterans, and as such, the generalizability of the results is limited to this population. In addition, our main findings were evident only in a subsample of combat veterans from the Vietnam War. The study also did not include structured diagnostic interviews to support our PTSD group assignments. However, prior evidence for the validity of our cut-offs on the PCL (Blanchard et al., 1996; Weathers et al., 1993) and our finding that the PTSD group scored higher on measures of psychopathology and trauma exposure should mitigate concerns about the validity of the group assignments in this study. We also did not include a measure of emotional numbing per se (aside from the PCL), which might have been useful in providing further description of emotional numbing in the sample. It is also conceivable that some of the Vietnam combat veterans with PTSD may have developed

PTSD in response to unmeasured traumatic experiences that occurred outside of the military which would render the Vietnam images less trauma-relevant for them. However, since combat veterans in this study were specifically instructed to complete the PCL in reference to their military experiences, it seems reasonable to draw a link between reports of current symptoms and Vietnam War experiences. This study was also limited in that it did not include the collection of psychophysiological data and it would have been desirable to examine the covariation of self-reported ratings and physiological indices of emotion using such a wide array of images.

It is noteworthy also that we measured emotion using the dimensions of valence and arousal and did not include ratings of discrete emotions; this makes it impossible, for example, to determine if differences in ratings of valence (e.g, lower valence ratings among the Vietnam combat veterans in response to the trauma-related images) reflect less pleasant and/or increased unpleasant emotion. It is possible that different results would have emerged had we also assessed discrete emotions, as has been shown previously (e.g., Amdur et al., 2000; Dunn et al., 2004). However, our decision to measure emotion along the valence and arousal continua has a strong conceptual foundation and empirical support (Russell and Mehrabian, 1977; Lang et al., 1993, 1998; Watson and Clark, 1997; Watson and Tellegen, 1985). Further, this dimensional approach to the measurement of emotion arguably provides a more parsimonious model linked to research on the neurobiology of emotion for testing hypotheses about the nature of the emotional processing abnormalities in PTSD. Finally, although our results might have differed had we employed autobiographical trauma scripts instead of standardized photographs, this limitation was arguably offset by the value of generating normative data for a standardized stimulus set that can be used in future research with this population.

In conclusion, the present study provides, to our knowledge, the first self-report evidence of exaggerated negative emotionality in response to unpleasant photographs, especially trauma-related ones, in individuals with PTSD. Heightened negative emotionality to trauma-related images was not associated with individual differences in combat exposure, or with the extent to which these images reminded veterans of their war experiences, or with depression, suggesting a PTSD-specific emotional processing abnormality. Veterans with PTSD in this study were no less reactive to emotional stimuli than were veterans without PTSD, despite reporting greater levels of numbing symptoms. Finally, these findings support the generalizability of theory regarding the basic 2-factor dimensional structure of emotion (Lang et al., 1993, 1998; Russell and Mehrabian, 1977) by extending this line of research into the realm of PTSD.

ACKNOWLEDGMENT

The authors thank Timothy A. Brown for his consultation on the data analyses.

REFERENCES

Allen NB, Trinder J, Brennan C (1999) Affective startle modulation in clinical depression: Preliminary findings. *Biol Psychiatry*. 46:542–550.

Amdur RL, Larsen R, Liberzon I (2000) Emotional processing in combat-related posttraumatic stress disorder: A comparison with traumatized and normal controls. *J Anxiety Disord*. 14:219–238.

American Psychiatric Association (1994) *Diagnostic and Statistical Manual of Mental Disorders* (4th ed). Washington, DC: American Psychiatric Association.

Blanchard EB, Jones-Alexander J, Buckley TC, Forneris CA (1996) Psychometric properties of the PTSD Checklist (PCL). *Behav Res Ther*. 34:669–673.

Bradley MM, Lang PJ (1994) Measuring emotion: The Self-Assessment Manikin and the Semantic Differential. *J Behav Ther Exp Psychol*. 25:49–59.

Casada JH, Amdur R, Larsen R, Liberzon I (1998) Psychophysiologic responsivity in posttraumatic stress disorder: Generalized hyperresponsiveness versus trauma specificity. *Biol Psychiatry*. 44:1037–1044.

Cedrus Corporation (1999) SuperLab Pro (Version 2.0) [Computer software]. San Pedro, CA: Cedrus Corporation.

Derogatis LR (1992) *The Brief Symptom Inventory (BSI): Administration, Scoring and Procedures Manual-II.* Baltimore (MD): Clinical Psychometric Research Inc.

Dunn BD, Dalgleish T, Lawrence AD, Cusack R, Ogilvie AD (2004) Categorical and dimensional reports of experienced affect to emotion-inducing pictures in depression. *J Abnorm Psychol*. 113:654–660.

Elsesser K, Sartory G, Tackenberg A (2004) Attention, heart rate and startle response during exposure to trauma-relevant pictures: A comparison of recent trauma victims and patients with posttraumatic stress disorder. *J Abnorm Psychol*. 113:289–301.

Empirisoft Corporation (1995–2002) MediaLab (Version 2002) [Computer software]. New York: Empirisoft Corporation.

Herman J (1997) *Trauma and Recovery.* New York (NY): Basic Books.

Glover H (1992) Emotional numbing: A possible endorphin-mediated phenomenon associated with posttraumatic stress disorders and other allied psychopathologic states. *J Trauma Stress*. 5:643–675.

Keane TM, Fairbank JA, Caddell JM, Zimering RT, Taylor KL, Mora CA (1989) Clinical evaluation of a measure to assess combat exposure. *Psychol Assess*. 1:53–55.

Lang PJ (1979) A bio-informational theory of emotional imagery. *Psychophysiology*. 16:495–512.

Lang PJ, Bradley MM, Cuthbert BN (1998) Emotion and motivation: Measuring affective perception. *J Clin Neurophysiol*. 15:397–408.

Lang PJ, Bradley MM, Cuthbert BN (2005) International Affective Picture System (IAPS): Affective Ratings of Pictures and Instruction Manual. Technical Report A-6. Gainesville (FL): University of Florida.

Lang PJ, Greenwald MK, Bradley MM, Hamm AO (1993) Looking at pictures: Affective, facial, visceral and behavioral reactions. *Psychophysiology*. 30: 2621–273.

Liberzon I, Taylor SF, Amdur R, Jung TD, Chamberlain KR, Minoshima S, Koeppe RA, Fig LM (1999) Brain activation in PTSD in response to trauma-related stimuli. *Biol Psychiatry*. 45:817–826.

Litz B (1992) Emotional numbing in combat-related post-traumatic stress disorder: A critical review and reformulation. *Clin Psychol Rev*. 12:417–432.

Litz BT, Orsillo SM, Kaloupek D, Weathers F (2000) Emotional processing in posttraumatic stress disorder. *J Abnorm Psychol*. 109:26–39.

Miller MW, Litz BT (2004) Emotional-processing in posttraumatic stress disorder II: Startle reflex modulation during picture processing. *J Abnorm Psychol*. 113:451–463.

Orr SP, Metzger LJ, Miller MW, Kaloupek DG (2004) Psychophysiological assessment of PTSD. In JP Wilson, TM. Keane (Eds), *Assessing Psychological Trauma and PTSD* (pp 289-343). New York (NY): The Guilford Press.

Orsillo SM, Batten SV, Plumb JC, Luterek JA, Roessner BM (2004) An experimental study of emotional responding in women with posttraumatic stress disorder related to interpersonal violence. *J Trauma Stress*. 17:241–248.

Protopopescu X, Pan H, Tuescher O, Cloitre M, Goldstein M, Engelien W, Epstein J, Yang Y, Gorman J, LeDoux J, Silbersweig D, Stern E (2005) Differential time courses and specificity of amygdala activity in posttraumatic stress disorder subjects and normal control subjects. *Biol Psychiatry*. 57:464–473.

Rauch SL, van der Kolk BA, Fisler RE, Alpert NM (1996) A symptom provocation study of posttraumatic stress disorder using positron emission tomography and script-driven imagery. *Arch Gen Psychiatry*. 53:380–387.

Rauch SL, Whalen PJ, Shin LM, McInerney SC, Macklin ML, Lasko NB, Orr SP, Pitman RK (2000) Exaggerated amygdala response to masked facial stimuli in posttraumatic stress disorder: A functional MRI study. *Biol Psychiatry*. 47: 769–776.

Russell JA, Mehrabian A (1977) Evidence for a 3-factor theory of emotions. *J Res Pers*. 11:273–294.

Shin LM, Orr SP, Carson MA, Rauch SL, Macklin ML, Lasko NB, Peters PM, Metzger LJ, Dougherty DD, Cannistraro PA, Alpert NM, Fischman AJ, Pitman RK (2004) Regional cerebral blood flow in the amygdala and medial prefrontal cortex during traumatic imagery in male and female Vietnam veterans with PTSD. *Arch Gen Psychiatry*. 61:168–176.

Shin LM, Wright CI, Cannistraro PA, Wedig MM, McMullin K, Martis B, Macklin ML, Lasko NB, Cavanaugh SR, Krangel TS, Orr SP, Pitman RK, Whalen PJ, Rauch SL (2005) A functional magnetic resonance imaging study of amygdala and medial prefrontal cortex responses to overtly presented fearful faces in posttraumatic stress disorder. *Arch Gen Psychiatry*. 62:273–281.

Sloan DM, Strauss ME, Quirk SW, Sajatovic M (1997) Subjective and expressive emotional responses in depression. *J Affect Disord*. 46:125–141.

Sloan DM, Strauss ME, Wisner KL (2001) Diminished response to pleasant stimuli by depressed women. *J Abnorm Psychol*. 110:488–493.

Spahic-Mihajlovic A, Crayton JW, Neafsey EJ (2005) Selective numbing and hyperarousal in male and female Bosnian refugees with PTSD. *J Anxiety Disord*. 19:383–402.

Watson D, Clark LA (1997) Measurement and mismeasurement of mood: Recurrent and emergent issues. *J Pers Assess*. 68:267–296.

Watson DT, Tellegen A (1985) Toward a consensual structure of mood. *Psychol Bull*. 98:219–235.

Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM (1993) The PTSD Checklist: Reliability, validity and diagnostic utility. Paper presented at: Annual meeting of the International Society for Traumatic Stress Studies, San Antonio, TX.

Wessa M, Karl A, Flor H (2005) Central and peripheral psychophysiological responses to trauma-related cues in subclinical posttraumatic stress disorder: A pilot study. *Exp Brain Res*. 167:56–65.